A Study of the Structural Relations in the Lower Limb

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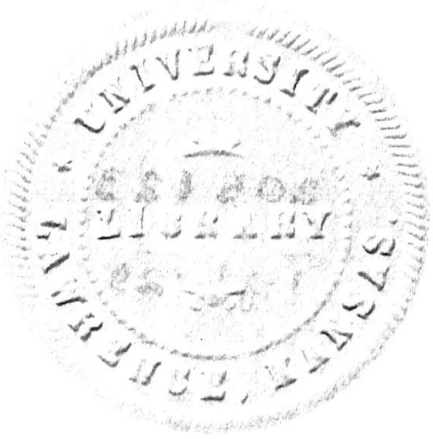

A STUDY

OF

THE STRUCTURAL RELATIONS

IN

THE LOWER LIMB.

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OUTLINE.

I. Introduction.

II. Embryology.

III. Relations of fascia.

IV. Relations of muscles, with arteries and nerves.

1. Pelvic girdle to thigh.

2. Thigh to crus--femoral.

3. Crus to tarsus--crural.

4. Tarsus to digits.

INTRODUCTION.

In the preparation for this study, cross sections were made of the right leg of cadaver number sixty one, in the Department of Anatomy of the University of Kansas. The leg measured seventeen and one half inches from the anterior superior iliac spine to the top of the patella, and from that point to the bottom of the external malleolus nineteen inches, a total of thirty six and one half inches. It also measured thirty six and a quarter inches from the top of the femur to the bottom of the heel. Parallel transverse sections were cut, the first one being two and one half inches thick and cut that distance below the superior anterior spine. The remaining sections were two inches thick, eighteen in all being cut down to the ankle. The nineteenth section was cut about an inch and a half thick and then the foot divided into four parts, paying no attention to exact thickness.

The leg was taken from the 3% carbolic solution in which the cadavers are preserved and after the sections had been cut they were washed in running water for about two weeks. They were then labeled, indexed and mounted in gelatin, preserved with 5 drops of formalin per 100 cc. Sections one and two were not mounted owing to mutilation, the result of previous dissection of the pelvis.

The drawings were made direct from the mounted sections. In the discussion of the embryology of the leg, I have relied on McMurrich's "The Development of the Human Body" and Piersol's "Human Anatomy". The study of the relations has been based upon the cross sections, with the aid of Deaver's "Surgical Anatomy", Piersol's "Human Anatomy", and Spalteholtz' "Hand Atlas of Human Anatomy".

A STUDY OF THE STRUCTURAL RELATIONS IN THE LOWER LIMB.

In order to obtain an adequate understanding of the innervation and relations of the lower limb muscles, it is necessary to trace their embryological development. Early in the life history of the embryo there appear on either side of the neural tube quadrilateral segments, the mesodermic somites, each soon dividing into two parts, a central sclerotome and a peripheral myotome, the latter giving rise to the greater part of the voluntary musculature of the body.

The limbs first make their appearance,in an embryo measuring about four millimeters, as two pairs of flat buds, the lower pair being situated in the lower lumbar and upper sacral regions. The myotomes of these regions send processes into the limb buds and give origin to at least a part of the musculature of the limb. Whether or not all of the muscles are developed from the myotomes is still a debated question, sufficient observations not yet having been made, but it is quite probable that a part of the musculature is derived from the core of mesenchyme which gives rise to the appendicular skeleton. However that may be, there is undoubtedly a fundamental connection between the musculature so developed and the segmented myotomes as shown by the relations of the muscles to the anterior divisions of the spinal nerves. The muscles of the lower limb are supplied by the lower four lumbar and first three sacral nerves,and their distribution may well be regarded as segmental, it being possible to recognise in the limb buds parallel, longitudinal bands of muscle tissue, which are supplied by the spinal nerves in definite segments. Each nerve has dorsal and ventral branches, and thus there are muscles on either side of the limb which correspond as

regards their innervation. On this basis, therefore, we have a ventral or preaxial and a dorsal or postaxial group of muscles. In the lower limb they are less definite than in the upper and it is more difficult to trace their innervation because of the rotation which the lower limb undergoes in changing from a quadrupedal condition to one in which the long axis of the limb is parallel with the long axis of the body. In order to accomplish this, the lower limbs rotate around two axes, one passing thru the hip joints, and the other the longitudinal axis of the limb itself, about which it rotates thru an angle of ninty degrees. The axial rotation of the lower limb is, however, in the opposite direction from that of the upper limb of the same side, causing them to bear different relations to the body, the radial side of the arm being external while the corresponding or tibial side of the leg is internal, and the palmar surface of the hand is directed ventrally, while the plantar surface of the foot is directed dorsally. This places the extensors of the arm on the dorsal surface, whereas the corresponding muscles of the leg on the anterior side are termed flexors, not as regards the leg itself, but in relation to the hip joint, and the movement of the foot upon the leg which corresponds to the flexion of the hand is termed extension. Thus the preaxial muscles of the lower limb are on the posterior side and the postaxial on the ventral side. The obturator and internal popliteal nerves therefore supply the preaxial muscles and the anterior crural and external popliteal supply the postaxial muscles. Altho the internal popliteal supplies the muscles on the back of the leg, its fibers lie anterior to those of the external popliteal as they emerge from the spinal foramina, which is manifestly in accordance with the foregoing statements.

Embryologically the second lumbar nerve supplies the most anterior muscles on the dorsum of the ilium, and from before backward the third, fourth and fifth lumbar and first and second sacral come in order. This same relation is maintained as we go down the limb, and in approximately this same order the nerves disappear. The muscle band supplied by the second lumbar extends to about the middle of the thigh, the third to the knee, the fourth to the middle of the leg, and

Spinal Innervation of Lower Limb Muscles.

2nd Lumbar	3rd Lumbar	4th Lumbar	5th Lumbar	1st Sacral	2nd Sacral	3rd Sacral

Pelvic Girdle to Thigh

Preaxial

- Psoas Magnus
- Iliacus
- Pectineus
- Gracilis
- Adductor Longus
- Adductor Brevis
- Adductor Magnus
- Quadratus Femoris
- Obturator Externus
- Obturator Internus
- Superior Gemellus
- Inferior Gemellus

Post Axial

- Gluteus Maximus
- Tensor Fascia Lata
- Gluteus Medius
- Gluteus Minimus

Femoral Muscles. From thigh and Pelvis to Crus.

Preaxial

- Short head of Biceps
- Long head of Biceps
- Semitendinosus
- Semimembranosus

Post Axial

- Sartorius
- Pectus Femoris
- Vastus Externus
- Crureus
- Vastus Internus
- Sub crureus

Crural Muscles. From Crus to Tarsus (and digits)

Preaxial

- Gastrocnemius
- Soleus
- Plantaris
- Flexor Longus Digitorum
- Flexor Longus Hallucis
- Tibialis Posticus
- Flexor Accessorius
- Popliteus

Post Axial.

- Tibialis Anticus
- Extensor Longus digitorum
- Peroneus Tertius
- Extensor Longus Hallucis
- Peroneus longus
- Peroneus brevis

Foot Muscles. From Tarsus to digits.

Preaxial.

- Flexor Brevis digitorum
- Flex. Brev. Hallucis
- Abductor Hallucis
- Abductor Minimi digiti
- Lumbricales
- Adductor Hallucis
- Interossei Plantares
- Interossei dorsales

Post Axial

- Extensor Brevis digitorum

the fifth to the base of the fifth metatarsal bone, while the first and second sacral bands extend into the foot, the first forming the inner muscles and the second the outer ones. From the outline on the previous page it will be seen that these conditions are but little changed in the adult, with the exception of the fourth lumbar nerve, which,with the fifth lumbar and first sacral, innervates the muscles going to the digits.

Not only is the extent of the nerve muscle bands changed in the adult thigh and leg, but their relations are also somewhat altered. Several causes enter in to change these longitudinal bands of embryonic muscle to the adult condition. In the first place, different bands have consolidated to form the different muscles, so that we have a condition in which a muscle may be supplied by more than one spinal nerve. On the other hand there has been a degeneration of some parts of the muscle bands equivalent to the formation of transverse segments, thus adapting them to action over the joints of the skeleton. Altho these changes may not occur definitely and in sequence in the embryo, comparative anatomy has clearly demonstrated their phylogenetic relation to the adult condition in man. Furthermore, there have been alterations produced by the end to end union of originally distinct muscles and by the migration of different muscles from their original point of attachment. Evidences of this alteration are found in the short head of the biceps femoris which is shown by comparative anatomy to belong to the gluteal muscles, and which has only secondarily become attached to the femur and united with the preaxial long head of the same muscle. This accounts for the short head being innervated by the external popliteal from the fifth lumbar and first and second sacral nerves the same as the gluteal muscles, whereas the long head is supplied by the internal popliteal from the first, second and third sacrals. For convenience however, the entire muscle is classed as preaxial. Likewise, the peroneus longus in lower animals takes its origin from the femur, but,thru an evolutionary process, it now arises from the fibula and the femoral portion has become transformed into the external lateral ligament of the knee. Thus, because of these changes, comparative

anatomy gives us a basis for the classification of the muscles of the lower limbs according to transverse groups, as follows:--1st. those from the pelvic girdle to the thigh, 2nd. from the thigh to the crus, 3rd. from the crus to the tarsus, and 4th. from the tarsus to the digits. Some modifications have arisen, however, owing to the fact that some of the muscles in man have undergone a further development and now pass over two joints.

Having thus dealt briefly with some phases of the development of the lower limb, we are now prepared for a consideration of its more important adult structures and the relations which they bear to each other. We will first discuss the fascia, and then the muscles, arteries and nerves together, from above downwards. By far the greatest space, however, will be devoted to the consideration of the muscles.

The superficial fascia over the buttocks, thigh and leg is very thin and loose and its superficial layer is continuous with that over the abdomen, scrotum and perineum. Over the buttocks this superficial layer is noticeably filled with adipose tissue, especially over the tuberosity of the ischium, and it is to this that the buttocks owe their roundness and prominence as well as to muscular development.

Beneath the superficial fascia in the thigh is the fascia lata, a thick, firm, fibrous covering, which completely envelops the muscles of the thigh except at the saphenous opening,and by its tension preserves their form and insures their coordinated action. At the saphenous opening in Scarpa's triangle, the fascia lata is very thin and sieve like and hence has received the name of cribriform fascia. On the lateral side of the thigh the fascia has become thickened into the strong ilio-tibial band, extending, as its name indicates, from the ilium to the tibia, and it receives in its upper part the insertion of the tensor fascia lata and a part of the gluteus maximus. In the upper part of the thigh the fascia is comparatively thin, but as we approach the knee it becomes heavier and stronger and is attached to the condyles of the femur, the patella, the tuberosities of the tibia and the head of the fibula, and receives tendinous attachments from the femoral muscles. On either side septa are given off

which become attached to the lips of the linea aspera on the femur, forming the internal and external intermuscular septa which separate the vastus muscles from the adductors and hamstrings respectively. See Plate II. Over the posterior side of the knee the fascia forms the roof of the popliteal space. In the region of the knee, therefore, it is seen to play a very important part in the formation of the tendinous structures which characterize that region.

The fascia lata is extended over the leg as the crural fascia which forms a complete sheath for its muscles. On the anterior surface of the tibia it blends with the periosteum. Two processes are sent in to be attached to the anterior and external surfaces of the fibula. These form the anterior and posterior intermuscular septa and separate the peroneus longus and brevis from the extensors in front and the flexors behind. See Plate III, Section XV. In the upper third of the leg there is another septum which separates the tibialis anticus from the extensor longus digitorum. At the ankle the fascia forms three strong bands, the internal, anterior and external annular ligaments which bind down the tendons of the extensor and flexor muscles and the anterior and posterior tibial vessels and nerves, as they pass from the leg into the foot. The crural fascia is continuous below with the fascia dorsalis pedis and the plantar fascia, which latter is very heavy and strong especially in its central portion and has much to do with maintaining the proper shape of the foot.

It will be recalled that in the discussion of the embryology of the lower limb, we found that the muscles could be classified longitudinally as preaxial and postaxial, and transversely as 1. those extending from the pelvic girdle to the thigh, 2. those from the thigh to the crus, or the femoral muscles, 3. those from the crus to the tarsus, or crural muscles, and 4. those from the tarsus to the digits, or foot muscles. While these divisions are not absolutely accurate for adult man because several of the muscles pass over more than one joint, the hamstrings, rectus femoris and sartorius, for instance, taking their origin from the pelvis instead of the thigh, they will yet be retained as they offer on the whole the most satisfactory classification.

In the preaxial muscles extending from the pelvis to the thigh, three distinct groups can be noted; the adductors, flexors and external rotators, the division being based upon their action. In general, the adductors are on the inner side between the flexors and extensors, the flexors on the posterior side of the thigh, and the external rotators on the posterior side of the head of the femur and the capsule of the hip joint.

The adductors are the gracilis, adductor longus, pectineus, adductor brevis and adductor magnus. The gracilis is the most internal and superficial of the adductors and in fact of the thigh muscles. It takes its origin by a broad tendon from the anterior surface of the body and inferior ramus of the pubis and extends down the thigh as a long flat muscle passing behind the inner condyle of the femur to its insertion on the inner side of the tibia below the tuberosity, and between the insertions of the sartorius and semitendinosus. The long saphenous nerve passes between the tendons of the gracilis and sartorius to become superficial. The adductor longus rises external to the gracilis, but from the body and superior ramus of the pubis. It extends obliquely down the thigh, forming the inner border of Scarpa's triangle, and is inserted into the middle third of the inner lip of the linea aspera between the adductor magnus and vastus externus. It lies anterior to the adductors brevis and magnus and anteriorly to it lie the femoral artery and vein and long saphenous nerve as they enter Hunter's canal which is formed by a membrane passing from the adductor longus and magnus to the vastus internus. External to the origin of the adductor longus the pectineus arises from the superior ramus and ilio-pectineal line of the pubis, and descends, parallel with the adductor longus, to be inserted into the pectineal line on the upper posterior part of the femur. Just external to the pectineus is the psoas magnus, with which it forms the floor of Scarpa's triangle, and is therefore in relation anteriorly with the femoral vessels. Behind, the pectineus rests upon the adductor brevis, obturator externus and the capsular ligament of the hip joint. The adductor brevis arises posterior to the pec-

tineus and adductor longus from the body and inferior ramus of the pubis. Behind and internal to it, the adductor magnus takes its origin from the inferior rami of the pubis and ischium and the tuberosity of the latter. The adductor brevis is inserted into the upper part of the inner lip of the linea aspera just posterior to the pectineus and adductor longus, while the latter is attached to almost the whole length of the inner lip, those fibers arising from the tuberosity of the ischium being prolonged into a tendon which is attached to the adductor tubercle on the inner condyle of the femur. From this it will be seen that the adductor brevis lies behind the pectineus and adductor longus, and in front of a part of the obturator externus and adductor magnus. External to it is a portion of the obturator internus and internally are the gracilis and adductor magnus. This latter is separated from the biceps, semitendinosus, semimembranosus and gluteus maximus muscles behind by a process from the fascia lata known as the posterior intermuscular septum. Hunter's canal which was spoken of before as lying between the adductor longus and vastus externus terminates in a tendinous arch in the insertion of the adductor magnus at the junction of the middle and lower thirds of the femur, and thus the femoral vessels pass to the other side of the muscle. At this point however, the long saphenous nerve leaves the canal, and, passing down between the vastus internus and adductor magnus, emerges to become superficial between the tendons of the gracilis and sartorius.

The preaxial flexors extending from the pelvic girdle to the thigh are the psoas magnus and iliacus. The former arises from the last thoracic and all the lumbar vertebrae and the latter from the upper half of the inner surface of the ilium. They leave the pelvis beneath Poupart's ligament, and form a part of the floor of Scarpa's triangle, the psoas magnus lying internal to the iliacus and between it and the pectineus, having the femoral vessels in front and the hip joint behind. Oftentimes the two muscles are extensively united, being known as the ilio-psoas. They are inserted by a common tendon into the lesser trochanter of the femur.

The preaxial rotators which are in a general sense ex-

ternal rotators in that their chief action is to rotate the thigh outward, are the pyriformis, superior gemellus, obturator internus, inferior gemellus, obturator externus and quadratus femoris. They lie beneath the gluteal muscles and appear from above downwards in the order named with the exception of the obturator externus which lies anterior to the quadratus femoris. The pyriformis arises from the ventral surface of the sacrum and the upper margin of the great sciatic foramen. All the others arise from the ischium or its ramus, the two obturators being attached also to the obturator membrane, internally and externally as their names indicate. With the exception of the quadratus femoris which is inserted into the linea quadrati, they are all attached to the greater trochanter or the floor of the digital fossa. Anteriorly the pyriformis rests upon the capsule of the hip joint and the gluteus minimus. Behind it is covered by the gluteus medius and maximus. Its upper border is crossed by the gluteal vessels and the superior gluteal nerve and its lower border by the sciatic and internal pudic vessels, and the pudic, inferior gluteal and great and small sciatic nerves. The position of the quadratus femoris is below the inferior gemellus, behind the obturator externus, in front of the gluteus maximus and above the adductor magnus. The great sciatic nerve, which emerges from the pelvis thru the greater sacrosciatic foramen below the pyriformis, crosses posteriorly in succession the superior gemellus, obturator internus, inferior gemellus, quadratus femoris and adductor magnus, entering the thigh by emerging from beneath the gluteus maximus.

The post axial muscles from the pelvic girdle to the thigh are the three gluteals and the tensor fascia lata. In general, they are abductors and internal rotators. The tensor fascia lata is a superficial muscle on the lateral side of the thigh, arising from the crest of the ilium behind the anterior superior spine and having its insertion in the iliotibial band, three or four inches below the greater trochanter. It lies just external to the sartorius. The gluteus maximus, the largest and coarsest muscle in the body, forms the principle part of the buttock and has its origin on the posterior surface of the ilium, the sacrum, the coccyx and the

great sacro-sciatic ligament. It is inserted into the iliotibial band and the gluteal ridge of the femur. The gluteus medius and minimus both have their origin from the outer surface of the ilium and both are inserted into the greater trochanter of the femur. The minimus lies over the hip joint and the posterior head of the rectus femoris and is covered partly by the pyriformis, but mostly by the medius which in turn has its posterior portion covered by the maximus. The anterior portion of the medius and the whole of the maximus are covered by the upper posterior portion of the fascia lata. The lower border of the gluteus maximus bounds the ischiorectal fossa.

There is but one group of preaxial femoral muscles, known as the flexors or hamstrings--the biceps, semitendinosus and semimembranosus. All three muscles have their origin from the tuberosity of the ischium, the biceps and semitendinosus by a common tendon and the semimembranosus by a flat tendon a little external to the others. The biceps has two portions, that arising from the ischium being the long head while the short head arises from the outer lip of the linea aspera and the external intermuscular septum extending from the insertion of the gluteus maximus to the outer condyle of the femur. The two heads form a common tendon which is inserted into the head of the fibula on the outer side. The semitendinosus passes behind the inner condyle of the femur to be inserted on the inner side of the tibia below the tuberosity, just beneath the insertion of the gracilis, and behind the broad insertion of the sartorius. The semimembranosus, so called because of the membranosus appearance of its upper and lower portions, is attached to the inner edge of the tibia behind the insertions of the gracilis and semitendinosus. Fibers are given off from the tendon of insertion to the capsular ligament of the knee joint and the deep fascia of the leg. In the thigh the semimembranosus is situated in front of the long head of the biceps and semitendinosus, and behind the adductor magnus. The great sciatic nerve which enters the thigh by emerging from beneath the gluteus maximus, descends upon the adductor magnus, having in relation posteriorly the long head of the biceps and lying along the external border of the semimembranosus. About the middle of

the thigh it divides into the external and internal popliteal nerves, and as such enters the popliteal space. This is a diamond shaped space on the back of the knee bounded below by the heads of the gastrocnemius and above externally by the biceps and internally by the semitendinosus, semimembranosus, gracilis and sartorius. Its floor is formed by the lower part of the femur between the two condyles and by the popliteus muscle. It is widest just behind the knee and deepest above the articular end of the femur. See Plate III, Section 11. It contains in the mid line the popliteal artery and vein and the internal popliteal nerve in the order from before backward of artery, vein and nerve. In the upper part of the space the nerve and vein lie external to the artery, but as they course thru the space they cross over so that the nerve is internal, the vein lying between the artery and nerve. The external popliteal nerve, the other division of the sciatic, passes thru the outer border of the space along the inner side of the biceps.

The postaxial femoral muscles are all extensors of the leg but one, the sartorius, which is a flexor. This is the longest muscle in the body and is superficial on the front of the thigh. In the series of sections it is seen to cross gradually from the outer to the inner side. Its origin is on the anterior superior spine of the ilium and its insertion on the inner side of the tibia above that of the gracilis and semitendinosus and yet spreading out over them. It forms the outer boundary of Scarpa's triangle, and, as it crosses the thigh in the groove between the rectus femoris and vastus internus and the adductors, it lies upon the roof of Hunter's canal. See Plates I and II. The extensors of the leg are the rectus femoris, vastus internus and externus and crureus. They are all classed together as the quadriceps extensor femoris, which may be said to occupy the front of the thigh between the ilio-tibial band on the outer side and the adductors on the inner side. The four muscles have differsnt origins but a common insertion. The rectus femoris is the middle one of the group and occupies the middle front of the thigh, being partly covered in its

upper part by the tensor fascia lata and the sartorius. Its origin is from the anterior inferior spine and the outer surface of the ilium. Posteriorly it rests upon the capsule of the hip joint and the crureus. The vastus externus and internus are on either side, the externus arising from the anterior intertrochanteric line, the greater trochanter and the outer lip of the linea aspera. The internus and crureus are usually blended and arise from the spiral line, inner lip of the linea aspera and the anterior surface of the femur and from the internal intermuscular septum. All four muscles unite in the common extensor tendon which is inserted into the upper border and sides of the patella and is continued downwards as the ligamentum patellae which has its insertion in the lower part of the tubercle of the tibia. The patella is in reality a sesamoid bone in the tendon of the quadriceps. This latter is separated from the hamstrings by the external intermuscular septum and from the adductors by the internal septum.

All of the preaxial crural muscles are extensors of the foot except the popliteus which is a flexor and an inward rotator of the leg. This small muscle arises from the outer condyle of the femur and is inserted into the posterior surface of the tibia. It forms the floor of the lower part of the popliteal space and is in relation posteriorly with the contents of that space and the gastrocnemius and plantaris muscles. At its lower border, or about one inch below the tubercle of the tibia, the popliteal artery divides into the anterior and posterior tibials, and about one inch lower down the posterior tibial gives off the peroneal.

The preaxial extensors of the foot are the gastrocnemius, soleus, plantaris, flexor longus digitorum, flexor longus hallucis, tibialis posticus and flexor accessorius. The gastrocnemius arises by two heads, the tendons being attached above either condyle of the femur, the origin of the outer head being above that of the popliteus. The soleus is a broad flat muscle arising beneath the gastrocnemius from the head and upper part of the fibula, the oblique line of the tibia and a tendinous arch between the two. The plantaris is a small muscle which arises above and internal

to the outer head of the gastrocnemius from the outer condyle of the femur. In cross sections it at first appears to be superficial to the gastrocnemius and then beneath it. It in fact curves over the outer head of that muscle, dips down between the two heads and its long tendon then lies between the gastrocnemius and soleus. It usually extends down to be inserted into the os calcis, but all three muscles amy be inserted into a common tendon, the tendo Achilles, which is of considerable size where it begins about the middle of the leg, but becomes narrower as it descends to its insertion into the os calcis. Along its outer border in the lower part are the short saphenous vein and nerve which higher up cross over and traverse the posterior surface of the gastrocnemius to enter the popliteal space, the nerve being formed by communicating branches from the external and internal popliteal. Since the gastrocnemius forms the lower lateral boundaries of the popliteal space its anterior surface is in relation with the popliteal vessels and internal popliteal nerve. The external popliteal nerve crosses the outer head as it follows the tendon of the biceps in leaving the popliteal space, and winds around the fibula about one inch below its head to pierce the substance of the peroneus longus where it divides into the anterior tibial and musculo cutaneus nerves.The posterior tibial vessels and nerve pass beneath the tendinous arch of origin of the soleus and thruout the larger part of the course down the leg are covered by the soleus and gastrocnemius.

The flexor longus digitorum lies on the inner side of the leg and arises from the posterior surface of the tibia from below the oblique line to about three inches above the internal malleolus. On the outer side of the leg the flexor longus hallucis arises from the lower two thirds of the posterior surface of the fibula and from the posterior intermuscular septum. Between these two muscles is situated the tibialis posticus which arises from the posterior surface of the interosseous membrane and the adjacent surfaces of the tibia and fibula. All three muscles terminate in tendons which extend around the ankle into the foot. Altho the

tibialis posticus lies between the flexor longus digitorum and flexor longus hallucis in the upper part of the leg, lower down it crosses over beneath the longus digitorum so that as they pass beneath the internal annular ligament the tendon of the tibialis posticus lies anterior to that of the flexor longus digitorum. The tibialis posticus is inserted principally into the scaphoid bone altho processes are sent to most of the other tarsal and metatarsal bones. The tendon of the flexor longus digitorum, after gaining the plantar surface of the foot, is directed laterally and receives the insertion of the flexor accessorius which arises from the os calcis. It then divides into four tendons which are inserted into the terminal phalanges of the second, third, fourth and fifth toes. The tendon of the flexor longus hallucis passes beneath the internal annular ligament behind that of the flexor longus digitorum and posterior to the tibial vessels and nerve. In the foot it passes above the tendon of the flexor longus digitorum and is inserted into the terminal phalanx of the great toe. The posterior tibial vessels and nerve, after passing under the tendinous arch of origin of the soleus, rest successively upon the tibialis posticus, flexor longus digitorum and the tibia in their course down the leg. In the upper part of the leg the nerve lies internal to the artery but later crosses over and becomes external. They leave the leg by passing beneath the internal annular ligament and divide into the external and internal plantar arteries and nerves respectively. Beneath the internal annular ligament then, from before backward, pass in order the tendons of the tibialis posticus and flexor longus digitorum muscles, posterior tibial artery and veins, posterior tibial nerve and the tendon of the flexor longus hallucis muscle. The peroneal artery, the largest branch of the posterior tibial,is given off about an inch below the bifurcation of the popliteal and lies between the soleus and tibialis posticus in the upper part of its course. Lower down it rests upon the interosseous membrane and is overlapped by the flexor longus hallucis. It enters the foot behind the external malleolus and anastomoses with the malleolar and external plantar arteries.

The postaxial crural flexors of the foot are the tibialis anticus, extensor longus digitorum, extensor longus hallucis and peroneus tertius. The tibialis anticus lies along the outer side of the tibia on the front of the leg and arises from the outer tuberosity and upper two thirds of the shaft of the tibia and from the crural fascia and interosseous membrane. In the lower part of the leg it forms a tendon which crosses obliquely over the ankle and passes thru the internal compartment of the anterior annular ligament to be inserted into the internal cuneiform and first metatarsal bones. On the lateral side of the tibialis anticus and between it and the peroneus longus lies the extensor longus digitorum. It arises from the outer tuberosity of the tibia, the upper three fourths of the fibula, the interosseous membrane, the crural fascia and the anterior intermuscular septum which separates it from the peronei muscles. It terminates about the middle of the leg in a tendon which passes theu the external compartment of the anterior annular ligament. It then divides into four tendons which go to the four outer toes and which receive the insertions of the interossei and lumbricales, and, in the case of the second, third and fourth toes, the insertion of the tendons of the extensor brevis digitorum. This latter muscle arises from the upper and outer surfaces of the os calcis and divides into four tendons, three ending as described above, the fourth being inserted into the base of the first phalanx of the great toe. From the lower fourth of the fibula, the interosseous membrane and the anterior intermuscular septum arises the peroneus tertius, in reality a part of the extensor longus digitorum. Its tendon passes thru the external compartment in the anterior annular ligament with the extensor longus digitorum to be inserted into the fifth metatarsal bone. Between the tibialis anticus and the extensor longus digitorum the extensor longus hallucis takes its origin from the middle of the inner surface of the fibula and the interosseous membrane. At first, the anterior tibial artery lies between this muscle and the tibialis anticus, but as it passes into a tendon it crosses over the artery and takes a position internal to it.

The tendon passes thru the middle compartment of the anterior annular ligament, thus lying between the tendons of the tibialis anticus and extensor longus digitorum, and is continued over the back of the foot to be inserted into the phalanges of the great toe.

The anterior tibial artery enters the front of the leg a little over an inch below the head of the fibula by passing above the interosseous membrane between the two heads of origin of the tibialis posticus. Thru the most of its course it rests upon the interosseous membrane but in the lower part it lies along the front of the tibia. In the upper part of the leg the artery lies between the tibialis anticus and the extensor longus digitorum. As the extensor longus hallucis arises between these two muscles, the artery lies between it and the tibialis anticus until crossed over by the hallucis tendon when it lies between the longus digitorum and the longus hallucis. In this relation it passes beneath the anterior annular ligament and is continued down the back of the foot as the dorsalis pedis artery. The anterior tibial artery is accompanied thruout its course by the anterior tibial veins and the anterior tibial nerve which branches off from the external popliteal below the head of the fibula and winds around that bone beneath the peroneus longus and the extensor longus digitorum to reach the interosseous membrane. The other terminal branch of the external popliteal is the musculo cutaneous which passes thru the substance of the peroneus longus, then between it and the peroneus brevis and finally descends the leg between the peroneal muscles and the extensor longus digitorum.

The peroneus longus and brevis are the postaxial extensors of the foot. They lie upon the outer side of the leg, separated from the other muscles by the anterior and posterior intermuscular septa. The longus arises from the upper two thirds of the outer surface of the fibula, the crural fascia and the intermuscular septa. Its tendon passes behind the external malleolus beneath the external annular ligament and courses around the outer side of the foot into the sole to become inserted into the internal cuneiform and first metatarsal bones. The peroneus brevis

has its origin beneath the longus from the lower part of the outer surface of the fibula. Its tendon passes thru the same compartment with that of the peroneus longus, but anterior to it, and is inserted into the fifth metatarsal bone. The peroneal muscles are separated from the soleus behind and the extensor longus digitorum internally by the intermuscular septa previously described.

There is only one postaxial muscle of the foot, the extensor brevis digitorum and this we have already considered with the extensor longus digitorum.

All of the other foot muscles are preaxial, and are flexors, abductors or adductors of the toes. The insertion of the interossei and lumbricales into the tendons of the extensor longus digitorum has already been mentioned. The remaining muscles are the flexor brevis digitorum, flexor brevis hallucis, abductor hallucis, abductor minimi digiti, adductor hallucis and flexor brevis minimi digiti. These muscles are comparatively small and are all found in the sole of the foot. The flexor brevis digitorum arises on the os calcis and its tendons are inserted into the four outer toes. The flexor brevis hallucis extends from the internal cuneiform bone to the great toe. The abductor hallucis lies along the inner border of the foot and the abductor minimi digiti along the outer border. Both arise from the os calcis and the plantar fascia and are inserted into the first phalanges of the first and fifth toes respectively. The adductor hallucis lies deeper and has two portions, its oblique portion arising from the bases of the second, third and fourth metatarsal bones, and the transverse portion from the capsules of the four outer matatarso-phalangeal joints. They both unite in a common tendon which is inserted into the first phalanx of the great toe. The flexor brevis minimi digiti, which is in reality an interosseous muscle, arises from the base of the fifth metatarsal bone and is inserted into the first phalanx of the little toe. All these sole muscles are firmly bound down by the strong plantar fascia from which several of them take a part of their origin.

The internal plantar artery which is the smaller of

the two divisions of the posterior tibial, enters the foot above the abductor hallucis and extends alomg the inner border between that muscle and the flexor brevis digitorum, anastamosing with the digital arteries. The external plantar, the principal artery in the sole of the foot, crosses to the outer side, at first between the flexor brevis digitorum and the flexor accessorius and later between the flexor brevis digitorum and the abductor minimi digiti. At the base of the fifth metatarsal bone it again crosses the foot, forming the plantar arch which anastamoses with the dorsalis pedis from the back of the foot. Both the plantar arteries are accompanied in their courses by the corresponding plantar nerves.

From this detailed description of the structures in the lower limb, it might perhaps be a little difficult to obtain a clear idea of the part as a whole, or of the action of the various muscles, singly or in coordination. Such however, is not the province of this paper. An effort has been made to make clear that the embryonic division of the muscles into more or less definite groups persists in the adult, altho different factors have entered in to alter their original position in several cases. It must be apparent, however, even to the casual observer, that whatever changes have taken place, such for instance as the union of different muscle bands either longitudinally or transversely or both, have produced a condition a condition of increased efficiency, and that whereas at one time the muscles of the lower limb were adapted for quadrupedal action, they are now constructed so as to serve man most faithfully in maintaining the upright position.

PLATE I. SECTION V.

Thru upper third of right thigh.

1. Long saphenous vein.
2. Lymph node.
3. Adductor longus.
4. Sartorius.
5. Femoral artery.
6. Anterior crural nerve.
7. Femoral vein.
8. Rectus femoris.
9. Deep femoral vessels.
10. Adductor brevis.
11. Vastus internus.
12. Gracilis.
13. Tensor fascia lata.
14. Crureus.
15. Femur.
16. Adductor magnus.
17. Vastus externus.
18. Semitendinosus.
19. Great sciatic nerve.
20. Long head of biceps.
21. Fascia lata.
22. Gluteus maximus.
23. Adipose tissue.

PLATE I

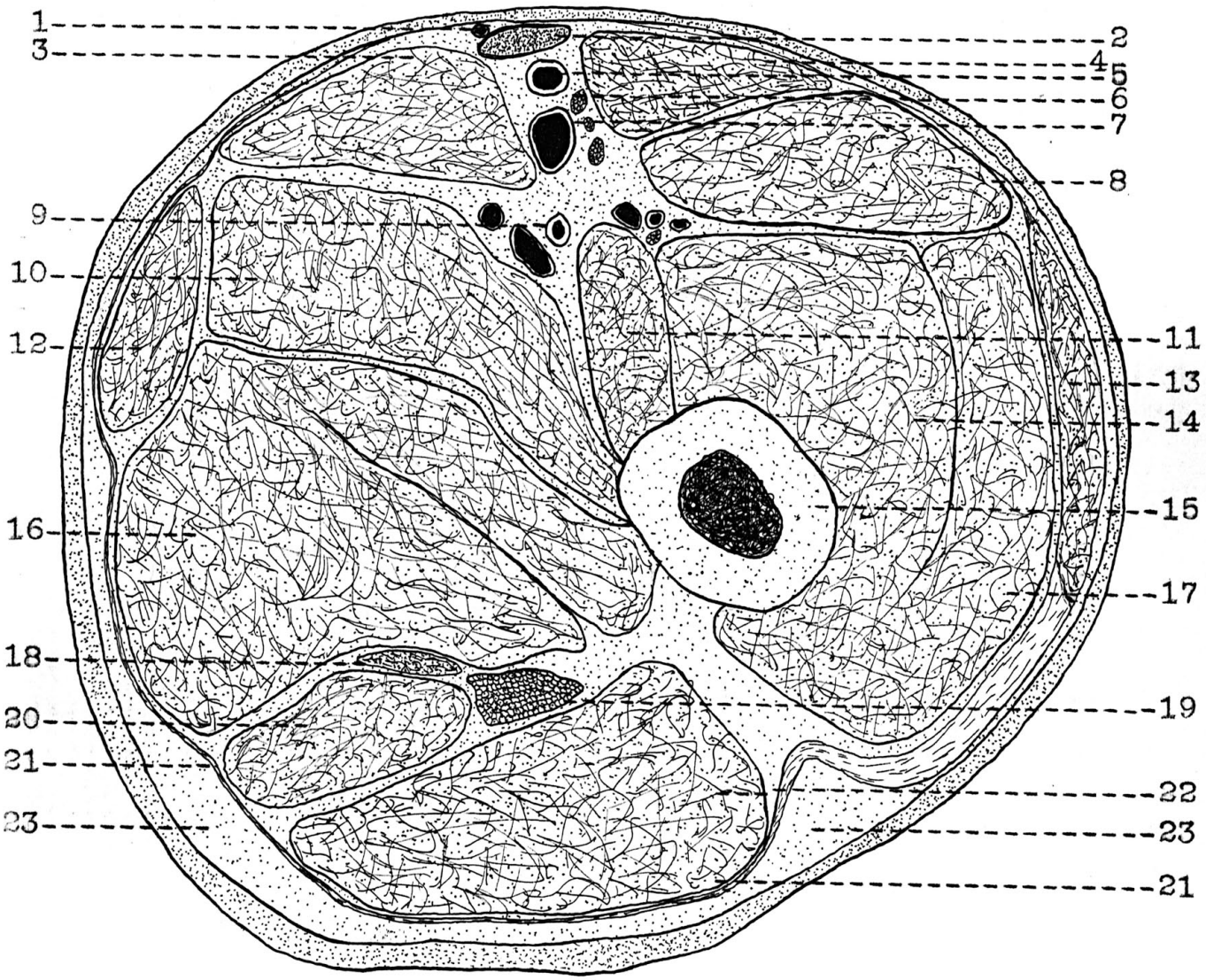


PLATE II. SECTION VIII.

SECTION OF RIGHT THIGH THRU HUNTER'S CANAL.

1. Sartorius.
2. Vastus internus.
3. Gracilis.
4. Internal saphenous nerve.
5. Femoral vessels in Hunter's canal.
6. Adductor magnus.
7. Semimembranosus.
8. Internal intermuscular septum.
9. Rectus femoris.
10. Femur.
11. Crureus.
12. Vastus externus.
13. Great sciatic nerve.
14. Short head of biceps.
15. External intermuscular septum.
16. Semitendinosus.
17. Long head of biceps.

PLATE II.

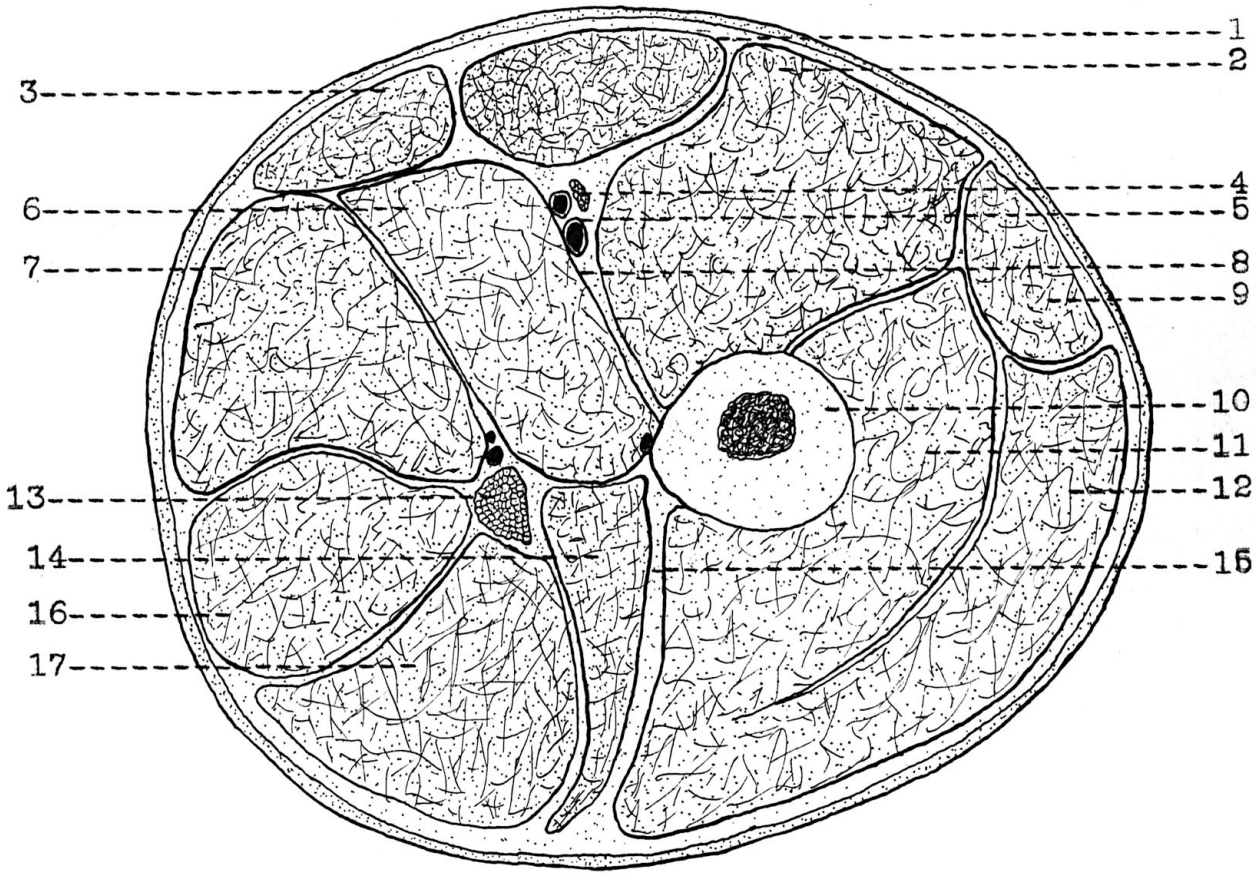
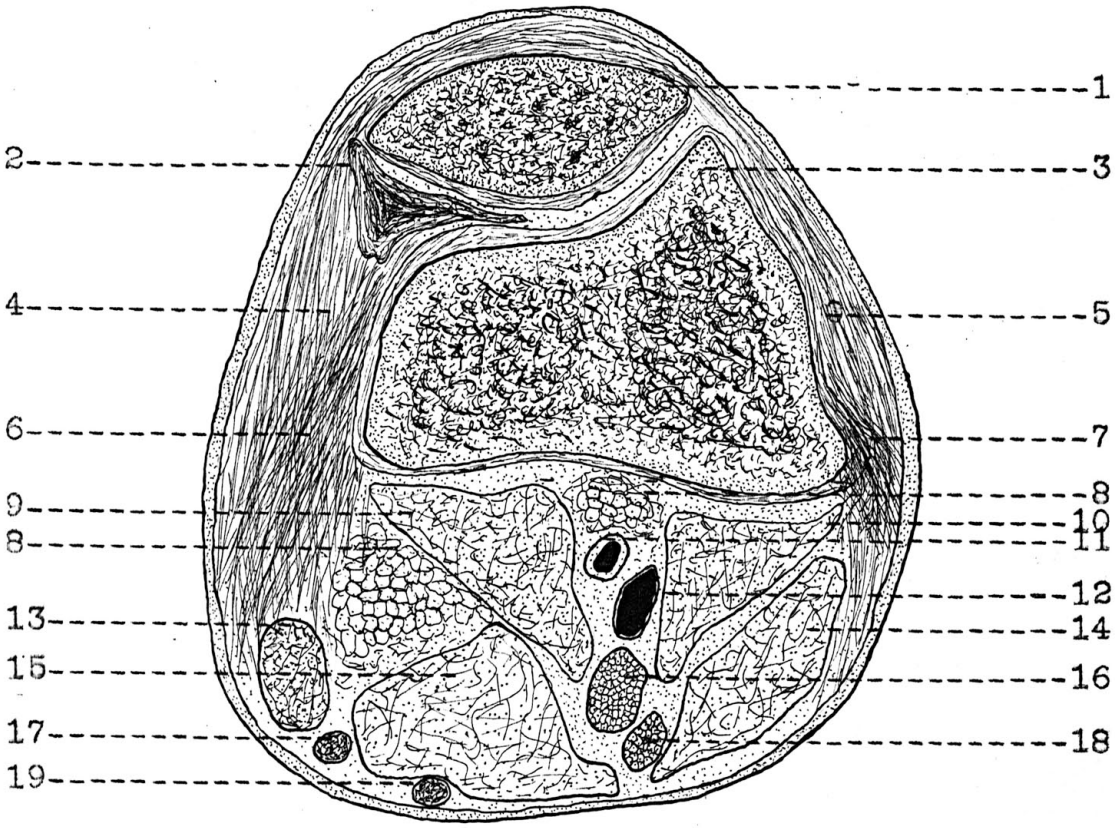


PLATE III.

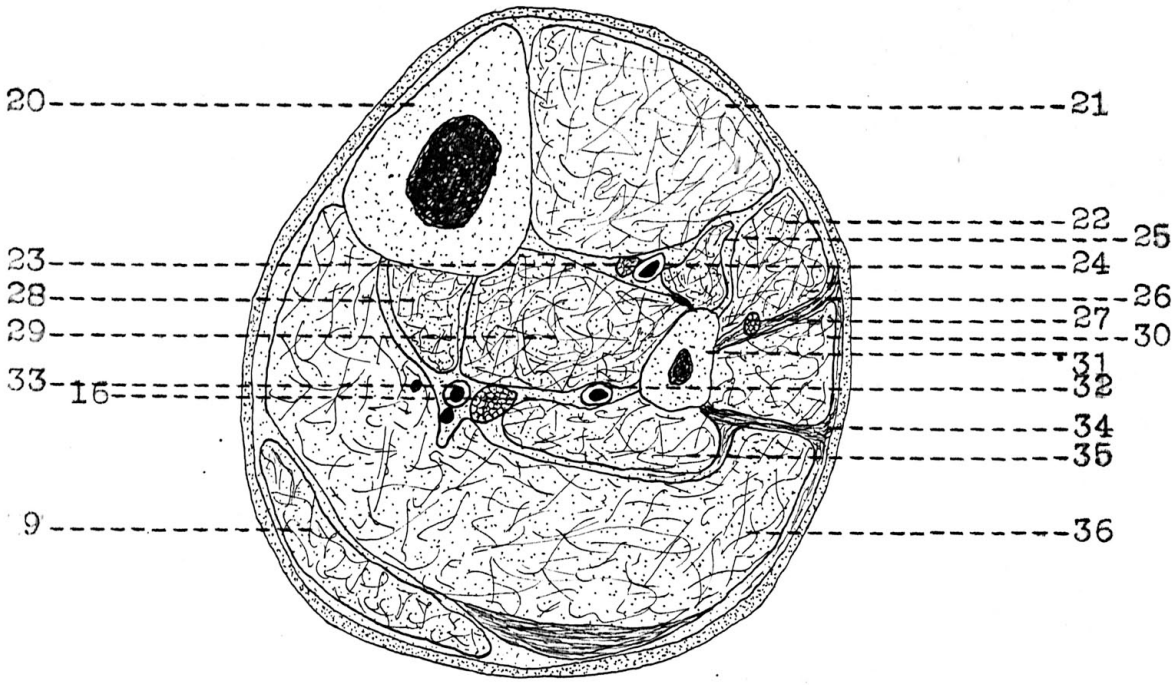
Section 11, thru knee.
Section 15, thru middle of leg.

1. Patella.
2. Synovial sac.
3. Femur.
4. Retinaculum Patellae Mediale.
5. Retinaculum Patellae Laterale.
6. Internal lateral ligament.
7. External lateral ligament.
8. Adipose tissue.
9. Gastrocnemius.
10. Plantaris.
11. Popliteal artery.
12. Popliteal vein.
13. Sartorius.
14. Short head of biceps.
15. Semimembranosus.
16. Internal popliteal or tibialis nerve.
17. Gracilis.
18. External popliteal or peroneus communis nerve.
19. Semitendinosus.
20. Tibia.
21. Tibialis anticus.
22. Extensor longus digitorum.
23. Anterior tibial nerve.
24. Anterior tibial artery.
25. Extensor longus hallucis.
26. Anterior intermuscular septum.
27. Musculo-cutaneus nerve.
28. Flexor longus digitorum.
29. Tibialis posticus.
30. Peroneus longus and brevis.
31. Fibula.
32. Peroneal artery.
33. Posterior tibial artery.
34. Posterior intermuscular septum.
35. Flexor longus hallucis.
36. Soleus.

PLATE III.



SECTION 11.



SECTION 15.